

Personal Protection Device (PPD) Maintenance & Technical Manual

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1.0 INTRODUCTION

The Senstar-Stellar personal protection device (PPD) is a body-worn radio transmitter, which emits an alert signal when activated. The PPD is intended to be worn on the belt of the user. When used in a facility equipped with the Senstar-Stellar Flash™ or Flare™ system, the transmitter notifies security staff an alarm transmission has occurred and reports the location of the user on a computerized map of the facility (Flare ONLY). Each PPD is identified by a unique ID code. The PPD is activated by pressing the red button on the front of the unit. The unit may also be equipped with an optional 'man-down' module and/or a tamper detection lanyard.

The PPD is activated by pressing the red button on the front of the unit. Optional activation methods include removing a lanyard/pull-pin assembly and an automatic “man-down” mode that is initiated based on the tilt angle of the transmitter.

This manual contains operating instructions for the PPD unit, care and maintenance instructions, as well as a detailed theory of operations.

2.0 OPERATIONS AND MAINTENANCE

2.1 Operating Instructions

2.1.1 Wearing the PPD

Always wear the PPD on the belt in a location that permits easy access to the push button or pull-pin. It is recommended the unit be used with the optional carrying holster for added protection. Insert the PPD into the pouch with the logo-end first taking care to line up the button with the hole in the pouch. The significance of this is to avoid covering the antenna (mounted under the logo) with your hand when reaching down to press the activation button. The performance of the unit is not degraded if worn under clothing. If the unit is equipped with an external antenna, do not wrap the antenna around the PPD – leave it hang vertically from the end of the PPD.

The leather holster is equipped with a loop over the top of the unit to secure the PPD. To remove the PPD from the holster, unsnap the retaining loop and pull on the end of the PPD (in new holsters, this pulling action may need to be accompanied by a push on the step of the housing that is exposed in the push-button area). The holster is secured to the belt using an integral belt loop. This loop is secured to the holster using polarized snaps. These snaps are polarized such that they can only be removed by prying the snaps open with the fingers positioned under the snap end of the belt loop. This takes a little practice. The purpose of the polarized snaps is to prevent the unit from being pulled off the belt by force. To close the belt loop snaps, reverse the motion used to open them.

2.1.2 Activation

The PPD is activated by pressing the red button on the outside of the unit. For optimum reliability, feel for the raised centering dot on the button before pressing. The unit transmits a unique ID code once each time the PPD is activated. It takes approximately one quarter (.25) of a second for the transmitter to complete the alarm sequence once the unit is activated. The alarm will be detected by the computer monitor within .5 seconds of activation.

Low Battery Detection (Automatic Activation)

The PPD continuously monitors its battery voltage. If the battery voltage drops below a pre-defined threshold, the unit automatically emits a low battery transmission to inform the head end software that a particular ID transmitter has a low battery. [NOTE: This requires that your facility has purchased the OPTIONAL low battery detection software.] The PPD is still capable of transmitting ten times after reaching the low battery threshold. After the automatic low battery transmission has occurred, the PPD will append a low battery transmission after each subsequent alarm activation to remind the head end operator. Units in low battery mode should be taken out of service. Battery replacement is a maintenance function.

Pull-Pin Option

Pull-pin version PPDs are activated by completely removing the pull-pin from its jack on the top of the PPD. The pull-pin is equipped with a flexible lanyard to make activation easier. The lanyard can be looped over a belt clip to force the PPD to alarm if it is ever removed from the wearer. Re-inserting the pull-pin in does not prevent the transmitter from sending the alert signal.

Always return the pull-pin to its mating plug in the PPD housing so that the unit is armed and to prevent the pull-pin from becoming lost. Do not cover the PPD with your hand when activating – simply press the button or remove the pull-pin.

Man-Down Option

If the PPD is equipped with a man-down option, it will automatically activate if the unit remains tilted too long. The default length of time of continuous tilt is 15 seconds. Consult the factory if you wish to alter this time period – it can be programmed by the system administrator at your facility. The default tilt angle threshold is 45 degrees. Consult the factory if you wish to alter this tilt angle – it can be programmed by the system administrator at your facility. To help prevent false alarms, the unit emits a warning tone once the 15 second timer begins counting. If the unit is returned to vertical, the warning tone is silenced and the timer is reset. If the unit remains tilted continuously for 15 seconds, the PPD will automatically activate an alarm transmission. The default mode is to transmit one time only following a man-down condition. Consult the factory if you wish the unit to continue to transmit – it can be programmed by the system administrator at your facility.

2.1.3 Testing

Senstar-Stellar recommends staff test the PPD at the beginning of each shift. Your facility administrator will develop a procedure for you to warn the security staff that a test transmission is under way and for the security staff to communicate to you that the unit has passed. Follow their established procedures. The battery is designed to support testing the basic PPD (no man-down option) three times per day for one year before battery replacement is required.

2.2 Do's and Don'ts

DO:

- DO - Always wear the PPD on your belt.
- DO - Always position the PPD on your belt such that the red button or pull-pin is accessible.
- DO - When activating the alarm, feel for the bump in the center of the red button before pressing.
- DO - Always wear the transmitter with the logo face facing away from your body.
- DO - If your PPD fails to transmit upon activation, turn the unit into maintenance immediately.
- DO - If you accidentally press the red button or remove the pull-pin, contact security immediately to report the false alarm.

DON'T

- Don't - Submerge the PPD in water or expose it to pounding rain.
- Don't - Cover the unit with your hand or metal objects while transmitting.
- Don't - Wear or store the PPD without the pull-pin completely inserted.
- Don't - Replace batteries unless you are a certified maintenance technician.
- Don't - Remove the marking labels on the transmitter.
- Don't - Drop or otherwise abuse the transmitter.
- Don't - Leave the transmitter unattended in the "tilted" position (Man-down units only).

2.3 Operator Maintenance and Cleaning

There are no operator-serviceable components or adjustments on the PPD. If the unit becomes soiled, wipe with a damp (not dripping) cloth or paper towel. Do not use other solvents or cleaning agents on the transmitter housing. If the carrying pouch becomes saturated with moisture, obtain a new pouch since this can potentially impact accuracy (Flare systems only). Battery replacement is a maintenance function due to the fact that the low battery detection software must be reset. Battery replacement is discussed elsewhere in this manual.

If included with your system, the PPD outer protective case (carrying pouch) is made from genuine leather. It should be cleaned and cared for as for any leather product (e.g., periodically clean and moisturize with saddle soap or other leather cleaner). Remove the PPD from the leather case before cleaning to avoid contacting the PPD itself with the cleaning solution.

2.4 Accessories

Senstar-Stellar PPD Carrying Pouch

Programming Board and Software (Sets Transmitter ID and Man-Down Programmable Options)

Battery Cover Torx™ Security Driver, Size T8 – Not Included

(McMaster Carr #7233A61)

Man-Down Module - [Optional]

Pull Pin & Lanyard - [Optional]

3.0 BATTERY SPECIFICATIONS AND REPLACEMENT

3.1 Battery Life Specification and Considerations

DC Power Source +9V nominal battery

Duracell, MN1604, Alkaline

DC Current Consumption 110 mA +/- 20 mA (during full transmission)

The end of life of the PPD is defined as the point at which the battery voltage drops to 7.0 VDC. At this voltage, the transmitter will still transmit reliably ten times at low temperatures. When the transmitter detects voltages at or below this level, it automatically emits a unique code identifying that it is in low battery mode. The head end software will only recognize this event if it has been purchased with the low battery detection option.

The transmitter has been designed and tested to comply with the following battery life specification:

One year of continuous operation, transmitted three times per day, operated at room temperature, with no optional features included.

Under normal operating conditions, the battery life will exceed more than one year.

Factors affecting battery life include:

A) Operating Temperature

Low temperatures will decrease battery output voltage and, as a result, shorten the battery life. It may be observed that a unit operates correctly indoors (at room temperature), but will experience sufficient voltage drop when used outdoors (in cold environment) for activating the automatic low battery detection transmission. If this occurs, take the unit out of service immediately.

[NOTE: Senstar-Stellar PPD transmitters have been independently tested and shown to achieve over 3,000 transmissions at -40 degrees Celsius before the low battery threshold was observed].

B) Number of Activations

Every time the transmitter is activated, it draws 110 mA for a short period. This consumes battery capacity. Under ideal conditions (with a new battery at room temperature), independent tests have shown the PPD transmitter to achieve over 30,000 transmissions.

C) Optional Features (Man-Down)

The man-down feature reduces battery life due to the increased standby current drain and due to the fact that the unit will “wake up” every time it is tilted and start emitting tones. The number of times the unit is tilted is a variable beyond the manufacturer’s control, so a battery life specification is more difficult to define. The battery life is defined as follows for the Man-Down option:

One year of continuous operation at room temperature assuming no manual activations or automatic activations (due to tilt) during the year. Following the one year under these conditions, the unit will be capable of automatically activating due to a tilt or manually activating using the pushbutton.

D) Hours of Standby Operation

The standard transmitter (no options) consumes a steady current drain of 16 microamperes. At this rate, the PPD consumes 25% of its original battery capacity merely by having the battery installed in the unit. Furthermore, commercial alkaline batteries typically degrade 10% to 15% per year in (this is the effect of so-called “shelf life” on battery capacity). If the PPD is to be stored on a shelf for several years, remove the battery or expect to replace the battery before putting that PPD back in service.

The man-down option causes the standby current of the transmitter to increase to 50 microamperes nominally. One year of standby operation will effectively consume the battery capacity of a 9 Volt alkaline cell.

3.2 Battery Replacement

Currently, 2 types of transmitters exist. 1] Transmitters requiring additional programming to reset the 'low battery detection' warning and 2] Transmitters requiring NO additional programming once the battery has been replaced.

The serial numbers on the back of the transmitter (PPD) is used to differentiate between the two (2) model types. Transmitters carrying serial numbers below 5599 will require additional programming to reset the 'low battery detection' after the battery is replaced. Transmitters carrying serial numbers above 5600 do not require additional programming. Once the battery has been replaced, the reset is automatically performed.

Battery Removal:

The battery is accessed by removing the battery cover (refer to Figures 3.2a and 3.2b below). Always open the battery cover at a workstation equipped with electrostatic discharge (ESD) protection. Static sensitive components are exposed when the battery cover is removed. Removal requires a Torx™ security driver, Size T8 (McMaster Carr #7233A61). Remove the four screws.

Remove the battery from the battery compartment by gently tapping the transmitter case against the palm of the hand while the battery cover is removed. The battery will fall into your hand, retained by the flying leads of the battery clip. Carefully unsnap the battery clip and discard the old battery.

Replacement of Battery Following Low Battery Detection: Serial Numbers Less Than 5599

If the battery is being replaced due to low battery detection, the PPD must be reset before returning it to operation. Before reconnecting the new battery, plug the PPD programming board into the programming connector slot within the battery compartment. Make sure the programming board jumper is in the position shown in Figure 3.2c. While the programming board is plugged in, plug in the new battery to the battery clips (plug is polarized and will only snap on in one position). Remove the programming board.

Place the battery into the battery compartment making sure the flying leads dress into the housing. Replace the battery cover and four screws taking care not to over-tighten the self-tapping screws. (Refer to PPD Programmer Manual for additional details concerning battery replacement and programming).

Replacement of Battery Following Low Battery Detection: For Serial Numbers Greater Than 5600

Once the battery has been replaced, no additional programming is necessary to reset the 'low battery detection'. This step is completed automatically.

Replacement of Battery before Low Battery Detection:

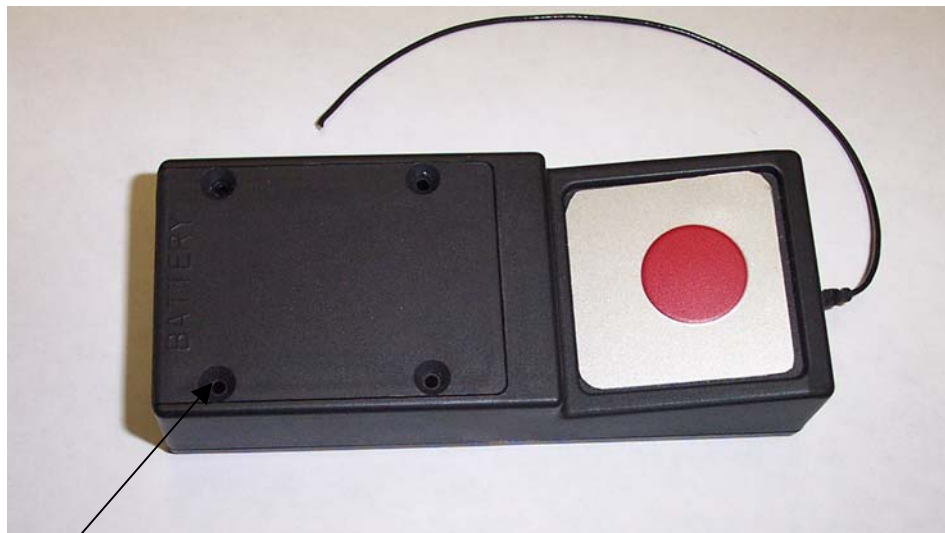
Anytime a new battery is installed in the unit, the Low Battery Reset procedure defined above must be followed. The act of unplugging the battery will cause the PPDs low battery indicator to go true. This is true even if a good battery is removed and then re-installed in the unit.

CAUTION

Replace only with the same or equivalent type battery recommended by the manufacturer. Dispose of used batteries according to the manufacturer's instructions.



Figure 3.2a



Battery Cover Screw location
(4 each)

Figure 3.2b

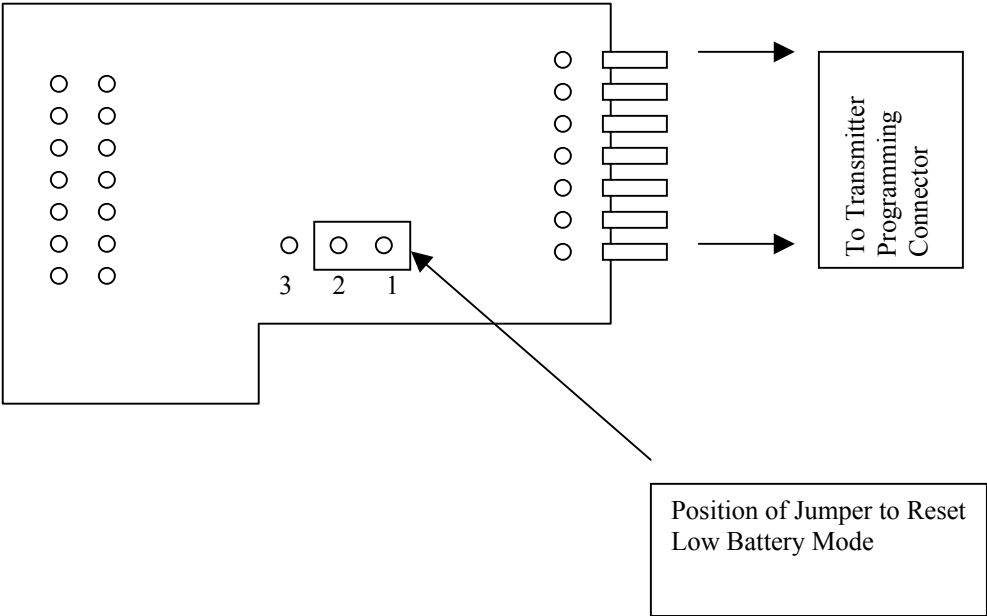
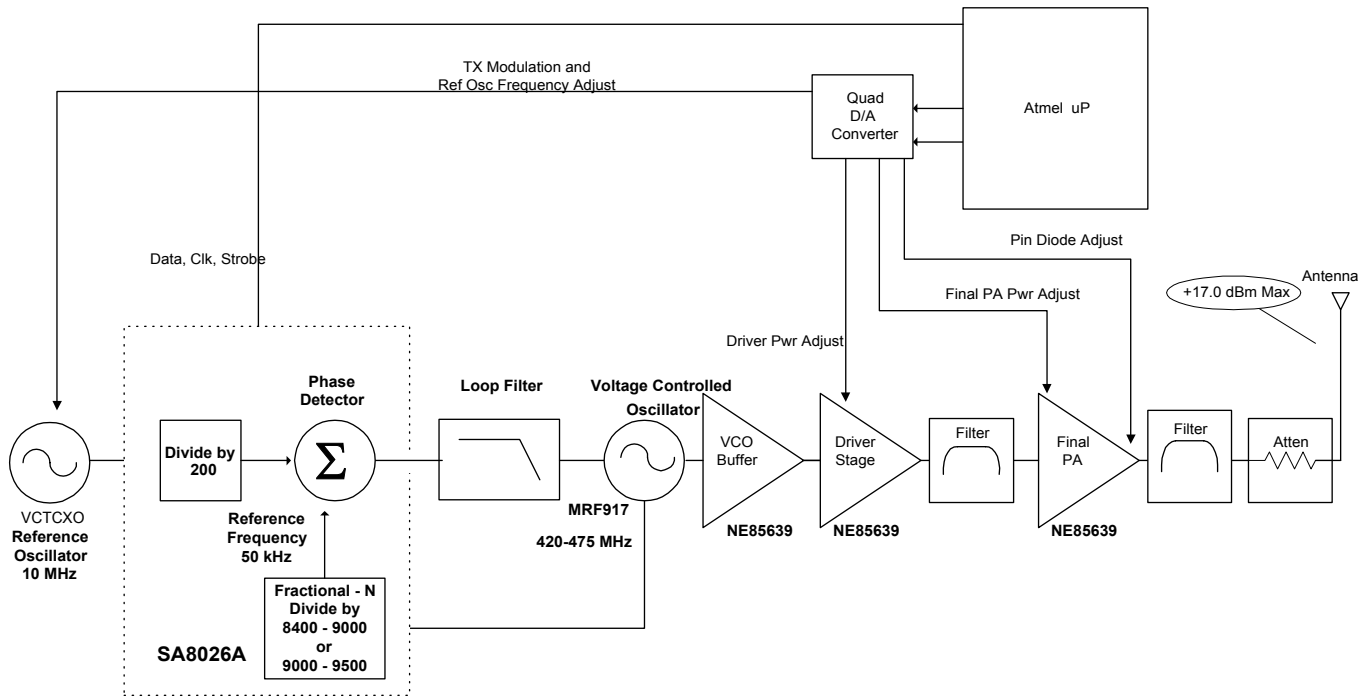


Figure 3.2c

4.0 PPD THEORY OF OPERATION

The PPD unit's electrical functional block diagram is illustrated below. This shows the unit elements of the controller/digital and RF sections. For a more complete description of the unit elements, refer to the sections below.

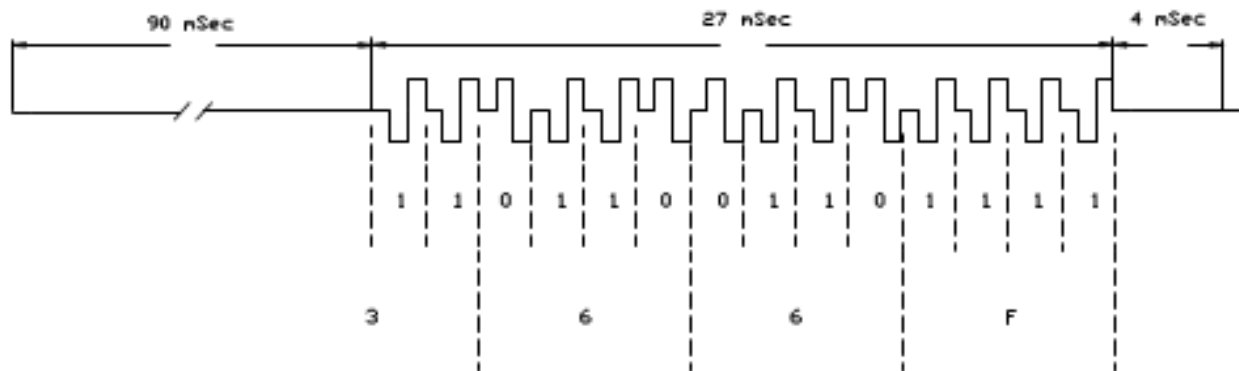


4.1 Transmitter Specifications

Model No:	B76060
Supply Voltage	9 VDC (Duracell MN1604)
Current Drain:	110 mA when active, 16 microamperes standby.
Temperature	-40 Deg C to +60 Deg C
Operating Frequency Range	420-470 MHz
Channel Resolution	6.25 kHz
Output Power	17.0 dBm +/- 2 dB, measured into 50 Ohm
Load Impedance	50 Ohm
Modulation	2-FSK
Average Deviation	2.00 kHz +/-100Hz
Radiated Spurious Output	per FCC Part 90, Industry Canada
Radiated Harmonic Output	per FCC Part 90, Industry Canada
FCC ID:	OQUB76060
Industry Canada ID:	3527195632
CSA Registration No:	163213

4.2 Digital Modulation

The digital modulation used in the Senstar-Stellar PPD unit is a tri-level 2-FSK format; i.e., the carrier frequency is part of the modulated waveform. The base band waveform is redrawn below for a sample ID word 366f (hex).



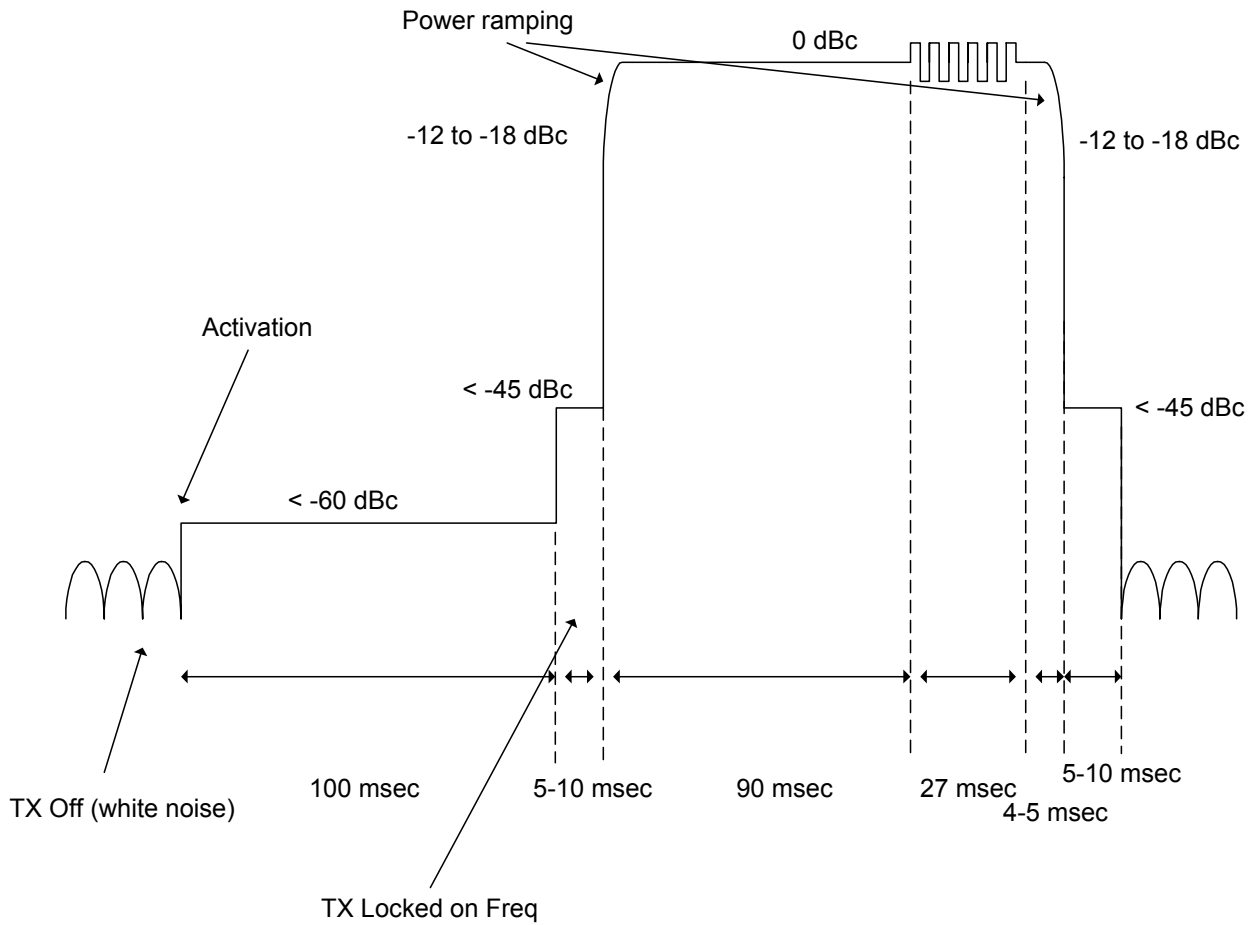
Transmitted data waveforms are generated by the microcontroller (Atmel AT90S2313) and fed to the quad digital-to-analog converter (DAC - MAX533-pin 15). This DAC output waveform is fed to the reference oscillator voltage controlled, input port (U3 - pin 1). The maximum voltage swing on the reference oscillator is 0.5 V to 4.5 V ($\approx \pm 10$ ppm). This corresponds to a maximum possible deviation swing at the transmitter output of 4.7 kHz peak.

The DAC has 8-bit resolution and deviation is controlled by setting the DAC output swing in the factory. The VCTCXO is modulated with data and the transmitted deviation is measured with a modulation analyzer at the antenna output. The test procedure requires the DAC peak-peak voltage swing to be varied until the appropriate data average deviation level is recorded. This level is saved in the microcontroller EEPROM and modulation limiting is provided via software setting of the DAC maximum output voltage. Deviation is tested and confirmed in the factory test station prior to shipment.

The transmitter was designed, using the appropriate data rate and deviation levels, to be compliant with Part 90.217(b) of the FCC rules. Per 90.217(b), there is a spectral emissions requirement and not a mask requirement. Hence, no data filtering is used.

4.3 RF Output

This section details critical timing and power ramping waveforms. The waveform below indicates the RF power levels versus time from the initial alarm activation to the end of the transmission sequence.



4.4 PPD Detailed Hardware Description

The following describes design goals for each of the functional unit elements in the PPD. This section provides typical performance characteristics of each unit element. These are not implied or guaranteed requirements and are intended for reference purposes only.

4.4.1 Synthesizer

The PPD synthesizer covers the frequency range from 420 – 470 MHz in selectable channel increments of 6.25 KHz. The customer specified operating frequency is factory set at time of test/alignment. The unit elements of the synthesizer are described below.

Phase Lock Loop Integrated Circuit

The synthesizer IC used in the PPD unit is a Philips SA7026A. This is a dual fractional-N synthesizer with a three-wire serial bus interface. For the PPD unit, only the main synthesizer is used. The synthesizer is loaded with divider ratios and related data by the microcontroller on the three-wire bus. 6.25 kHz channelization is realized by programming the main and reference dividers to provide a 50 kHz phase detector comparison (reference) frequency and by operating the fractional-N accumulator in a modulo-8 mode. A sampled output of the driver amplifier is fed back to the PLL IC (SA7026A) to be divided down to the reference frequency of 50 kHz.

The SA7026A's voltage supplies are divided into digital and analog. The digital supply runs directly off the PPD's regulated 3.3v. The analog/charge pump supply runs off the output of a +5V regulator that is powered off a voltage "doubler" IC that boosts 3.3v up to approximately 6.6v. This technique provides added tuning range for the VCO, allowing only two frequency splits. The approximate current consumption of the synthesizer is 8 mA.

Loop Filter

This filter is comprised of a) a series RC to ground in shunt with the main charge pump of the SA7026A (with the capacitor connected directly to the SA7026A's speedup charge pump), b) a smaller-value capacitor in shunt with the main charge pump, and c) a final series-R shunt-C low pass section feeding the control port of the VCO.

Loop-response and modulation performance depend critically on specific component values, and much effort was put into balancing various constraints on the loop filter. Two major constraints were a) sufficient loop bandwidth so that the PLL would adequately track the 2-FSK-baseband-modulated VCTCXO signal to impart system-acceptable fidelity in the modulated waveform, and b) sufficient out-of-modulation-band rejection to suppress the synthesizer's reference spurs to levels acceptable for PPD operation and regulatory requirements.

4.4.2 Voltage Controlled Oscillator (VCO)

The VCO was implemented using a Motorola MRF917 BJT in a Colpitts oscillator configuration. The design provides a tuning frequency range of 420 – 475 MHz. For interference and EMI reasons, the VCO and VCO buffer circuits are enclosed in a shield that clips to the PCB.

The VCO varactor diode input is driven by the output of the PLL loop filter, setting the instantaneous transmitter frequency. The varactor is capacitive coupled into the VCO's L-C tank circuit.

4.4.3 VCO Buffer Amplifier

The VCO buffer amplifier was implemented using an NEC/CEL NE85639 bipolar RF transistor. The VCO buffer amp provides isolation and gain for the VCO output. The buffer amp provides approximately 13-15 dB of gain at its output.

The VCO buffer amplifier uses an RF-bypassed emitter-degeneration bias arrangement for good temperature stability. The buffer's input impedance is high so that loading effects on the VCO are minimized.

4.4.4 Reference Oscillator (VCTCXO)

The reference oscillator is a 10MHz voltage-controlled temperature compensated crystal oscillator (VCTCXO). It is manufactured by TEMEX, part number TTF 95V AAO 10.000. The voltage-controlled input of the reference oscillator has two functions, 1) frequency adjust via the dc offset on the voltage-controlled pin and 2) transmit modulation via an ac signal superimposed on the dc offset.

The VCTCXO voltage-control port is driven by the base band modulation waveform at an associated dc-offset, thus driving both the PPD's carrier frequency and deviation. Carrier frequency and average deviation are set by measuring the PPD in Test Mode with a modulation analyzer, then adjusting the base band modulation waveform's mid, low, and high voltages. These values are saved in the controller's EEPROM.

The reference oscillator is a 5 volt nominal part, rather than 3.3 volts, and gets its supply voltage from the same +5V regulator as the charge pump of the synthesizer. This was done to maximize the voltage-tuning range of the VCTCXO function to encompass a) modulation, b) carrier frequency trim, c) unit-unit variations, and d) crystal aging.

4.4.5 Driver Stage

The driver amplifier was implemented using a NEC/CEL NE85639. The driver amp has approximately 9-11 dB of gain at its output.

The driver amplifier uses a software settable bias circuit. During the factory test, the microcontroller will set the bias level of the driver amplifier by varying the quad DAC output voltage accordingly (MAX 533-pin 2) while measuring the bias current and/or output power. This bias set point effectively sets the current and gain of the driver amplifier stage.

To minimize gain variation over temperature, the driver amplifier implements a thermistor (RT1) in its bias circuit. The negative temperature coefficient, thermistor's resistance varies inversely with temperature to adjust the bias current in the device. This keeps gain constant over the environmental conditions defined for the PPD.

4.4.6 Band Pass Interstage Filter

The driver amplifier feeds the final power amplifier stage through a simple band pass filter consisting of a parallel inductor-capacitor in shunt with the driver amplifier's output. This provides spurious and out-of-band rejection prior to final stage amplification.

4.4.7 Final Amplifier

The final amplifier was implemented using a NEC/CEL NE85639 bipolar RF transistor. The final amp has approximately 9-11 dB of gain at its output.

